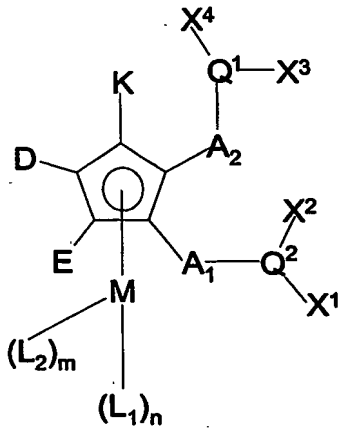
Claims

1. A compound obtainable by combining:

(a) a Group VIIIB metal or a compound thereof; and,

(b) a compound of formula I or salt thereof:



(I)

wherein:

A_1 and A_2, and A_3, A_4 and A_5 (when present), each independently represent lower alkylene;

K is selected from the group consisting of hydrogen, lower alkyl, aryl, Het, halo, cyano, nitro, $-OR^{19}$, $-OC(O)R^{20}$, $-C(O)R^{21}$, $-C(O)OR^{22}$, $-N(R^{23})R^{24}$, $-C(O)N(R^{25})R^{26}$, $-C(S)(R^{27})R^{28}$, $-SR^{29}$, $-C(O)SR^{30}$, $-CF_3$ or $-A_3-Q^3(X^5)X^6$;

D is selected from the group consisting of hydrogen, lower alkyl, aryl, Het, halo, cyano, nitro, $-OR^{19}$, $-OC(O)R^{20}$, $-C(O)R^{21}$, $-C(O)OR^{22}$, $-N(R^{23})R^{24}$, $-C(O)N(R^{25})R^{26}$, $-C(S)(R^{27})R^{28}$, $-SR^{29}$, $-C(O)SR^{30}$, $-CF_3$ or $-A_4-Q^4(X^7)X^8$;

E is selected from the group consisting of hydrogen, lower alkyl, aryl, Het, halo, cyano, nitro, $-OR^{19}$, $-OC(O)R^{20}$,

$-C(O)R^{21}$, $-C(O)OR^{22}$, $-N(R^{23})R^{24}$, $-C(O)N(R^{25})R^{26}$, $-C(S)(R^{27})R^{28}$, $-SR^{29}$, $-C(O)SR^{30}$, $-CF_3$ or $-A_5-Q^5(X^9)X^{10}$;

or both D and E together with the carbon atoms of the cyclopentadienyl ring to which they are attached form an optionally substituted phenyl ring:

X^1 represents $CR^1(R^2)(R^3)$, congressyl or adamantyl, X^2 represents $CR^4(R^5)(R^6)$, congressyl or adamantyl, or X^1 and X^2 together with Q^2 to which they are attached form an optionally substituted 2-phospha-adamantyl group, or X^1 and X^2 together with Q^2 to which they are attached form a ring system of formula 1a;

X^3 represents $CR^7(R^8)(R^9)$, congressyl or adamantyl, X^4 represents $CR^{10}(R^{11})(R^{12})$, congressyl or adamantyl, or X^3 and X^4 together with Q^1 to which they are attached form an optionally substituted 2-phospha-adamantyl group, or X^3 and X^4 together with Q^1 to which they are attached form a ring system of formula 1b;

X^5 represents $CR^{13}(R^{14})(R^{15})$, congressyl or adamantyl, X^6 represents $CR^{16}(R^{17})(R^{18})$, congressyl or adamantyl, or X^5 and X^6 together with Q^3 to which they are attached form an optionally substituted 2-phospha-adamantyl group, or X^5 and X^6 together with Q^3 to which they are attached form a ring system of formula 1c;

X^7 represents $CR^{31}(R^{32})(R^{33})$, congressyl or adamantyl, X^8 represents $CR^{34}(R^{35})(R^{36})$, congressyl or adamantyl, or X^7 and X^8 together with Q^4 to which they are attached form an optionally substituted 2-phospha-adamantyl group, or X^7

and X^8 together with Q^4 to which they are attached form a ring system of formula 1d;

X^9 represents $CR^{37}(R^{38})(R^{39})$, congressyl or adamantyl, X^{10} represents $CR^{40}(R^{41})(R^{42})$, congressyl or adamantyl, or X^9 and X^{10} together with Q^5 to which they are attached form an optionally substituted 2-phospha-adamantyl group, or X^9 and X^{10} together with Q^5 to which they are attached form a ring system of formula 1e;

Q^1 and Q^2, and Q^3, Q^4 and Q^5 (when present), each independently represent phosphorus, arsenic or antimony;

M represents a Group VIB or VIIIB metal or metal cation thereof;

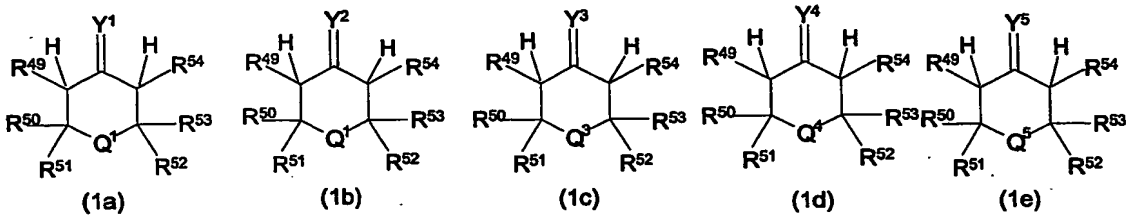
L_1 represents an optionally substituted cyclopentadienyl, indenyl or aryl group;

L_2 represents one or more ligands each of which are independently selected from hydrogen, lower alkyl, alkylaryl, halo, CO, $P(R^{43})(R^{44})R^{45}$ or $N(R^{46})(R^{47})R^{48}$;

R^1 to R^{18} and R^{31} to R^{42}, when present, each independently represent hydrogen, lower alkyl, aryl, halo or Het;

R^{19} to R^{30} and R^{43} to R^{48}, when present, each independently represent hydrogen, lower alkyl, aryl or Het;

the ring systems of formula 1a, 1b, 1c, 1d and 1e are represented by the formulae



R^{49}, R^{54} and R^{55}, each independently represent hydrogen, lower alkyl or aryl; R^{50} to R^{53} each independently represent hydrogen, lower alkyl, aryl or Het; and Y^1, Y^2, Y^3, Y^4 and Y^5, each independently represent oxygen, sulfur or N-R^{55};

n = 0 or 1;

and m = 0 to 5;

provided that when n = 1 then m equals 0, and when n equals 0 then m does not equal 0.

2. A compound as claimed in claim 1, wherein if both K represents $-A_3-Q^3(X^5)X^6$ and E represents $-A_5-Q^5(X^9)X^{10}$, then D represents $-A_4-Q^4(X^7)X^8$.

3. A compound as claimed in claim 1 or 2, wherein R^1 to R^{18} and R^{31} to R^{42} each independently represent hydrogen, optionally substituted C_1-C_6 alkyl or optionally substituted phenyl.

4. A compound as claimed in any one of claims 1 to 3, wherein R^1 to R^{18} and R^{31} to R^{42} each independently represent hydrogen or non-substituted C_1-C_6 alkyl.

5. A compound as claimed in any one of claims 1 to 3, wherein one or more of the groups R^1 to R^3, R^4 to R^6, R^7 to

R^9, R^{10} to R^{12}, R^{13} to R^{15}, R^{16} to R^{18}, R^{31} to R^{33}, R^{34} to R^{36}, R^{37} to R^{39}, R^{40} to R^{42} together with the carbon atom to which they are attached each independently form a cyclic alkyl structure.

6. A compound as claimed in any one of claims 1 to 3, wherein one or more of the groups R^1 and R^2, R^4 and R^5, R^7 and R^8, R^{10} and R^{11}, R^{13} and R^{14}, R^{16} and R^{17}, R^{31} and R^{32}, R^{34} and R^{35}, R^{37} and R^{38}, R^{40} and R^{41} together with the carbon atom to which they are attached each independently form a cyclic alkyl structure.

7. A compound as claimed in any one of the preceding claims, wherein each of R^1 to R^{18} and R^{31} to R^{42} does not represent hydrogen.

8. A compound as claimed in any one of the preceding claims, wherein adamantyl represents unsubstituted adamantyl or adamantyl substituted with one or more unsubstituted C_1-C_8 alkyl substituents, or a combination thereof.

9. A compound as claimed in any one of the preceding claims, wherein 2-phospha-adamantyl represents unsubstituted 2-phospha-adamantyl or 2-phospha-adamantyl substituted with one or more unsubstituted C_1-C_8 alkyl substituents, or a combination thereof.

10. A compound as claimed in any one of the preceding claims, wherein 2-phospha-adamantyl includes one or more oxygen atoms in the 2-phospha-adamantyl skeleton.

11. A compound as claimed in any one of the preceding claims, wherein congressyl represents unsubstituted congressyl.

12. A compound as claimed in any one of the preceding claims, wherein R^{50} to R^{53} each independently represent optionally substituted C_1-C_6 alkyl, trifluoromethyl or phenyl optionally substituted with non-substituted C_1-C_6 alkyl or OR^{19} where R^{19} represents non-substituted C_1-C_6 alkyl.

13. A compound as claimed in any one of the preceding claims, wherein R^{49} and R^{54} each independently represent hydrogen or non-substituted C_1-C_6 alkyl.

14. A compound as claimed in any one of the preceding claims, wherein each of Y^1 to Y^5 represents oxygen.

15. A compound as claimed in any one of the preceding claims, wherein X^1 is identical to X^3, and X^5, X^7 and X^9 when present.

16. A compound as claimed in any one of the preceding claims, wherein X^2 is identical to X^4, and X^6, X^8 and X^{10} when present.

17. A compound as claimed in any one of claims 1 to 14, wherein X^1 represents $CR^1(R^2)(R^3)$, X^2 represents $CR^4(R^5)(R^6)$, X^3 represents $CR^7(R^8)(R^9)$ and X^4 represents $CR^{10}(R^{11})(R^{12})$.

18. A compound as claimed in any one of claims 1 to 14, wherein X^1 represents $CR^1(R^2)(R^3)$, X^2 represents adamantyl, X^3 represents $CR^7(R^8)(R^9)$ and X^4 represents adamantyl.

19. A compound as claimed in any one of claims 1 to 14, wherein X^1 represents $CR^1(R^2)(R^3)$, X^2 represents congressyl, X^3 represents $CR^7(R^8)(R^9)$ and X^4 represents congressyl.

20. A compound as claimed in any one of claims 1 to 14, wherein X^1 to X^4 each independently represent adamantyl.

21. A compound as claimed in any one of claims 1 to 14, wherein X^1 to X^4 each independently represent congressyl.

22. A compound as claimed in any one of claims 1 to 14, wherein X^1 and X^2 together with Q^2 to which they are attached form a ring system of formula Ia, and X^3 and X^4 together with Q^1 to which they are attached form a ring system of formula Ib.

23. A compound as claimed in any one of claims 1 to 14, wherein X^1 and X^2 together with Q^2 to which they are attached form a 2-phospha-adamantyl group, and X^3 and X^4 together with Q^1 to which they are attached form a 2-phospha-adamantyl group.

24. A compound as claimed in any one of the preceding claims, wherein K represents hydrogen.

25. A compound as claimed in any one of claims 1 to 23, wherein K represents $-A_3-Q^3(X^5)X^6$.

26. A compound as claimed in claim 25, wherein $-A_3-Q^3(X^5)X^6$ is identical to $-A_2-Q^1(X^3)X^4$.

27. A compound as claimed in any one of the preceding claims, wherein D and E together with the carbon atoms of the cyclopentadienyl ring to which they are attached form an unsubstituted phenyl ring.

28. A compound as claimed in any one of the preceding claims, wherein D and E both represent hydrogen.

29. A compound as claimed in any one of claims 1 to 26, wherein D represents $-A_4-Q^4(X^7)X^8$.

30. A compound as claimed in claim 29, wherein $-A_4-Q^4(X^7)X^8$ is identical to $-A_2-Q^1(X^3)X^4$.

31. A compound as claimed in any one claims 29 or 30, wherein E represents hydrogen.

32. A compound as claimed in any one claims 1 to 26, 29 or 30, wherein E represents $-A_5-Q^5(X^9)X^{10}$.

33. A compound as claimed in claim 32, wherein $-A_5-Q^5(X^9)X^{10}$ is identical to $-A_2-Q^1(X^3)X^4$.

34. A compound as claimed in any one of the preceding claims, wherein A_1 and A_2, and A_3, A_4 and A_5 when present, each independently represent $-CH_2-$ or $-C_2H_4-$.

35. A compound as claimed in any one of the preceding claims, wherein each A_1 and A_2, and A_3, A_4 and A_5 when present are identical and preferably represent $-CH_2-$.

36. A compound as claimed in any one of the preceding claims, wherein each Q^1 and Q^2, and Q^3, Q^4 and Q^5 when present are identical and preferably represent phosphorous.

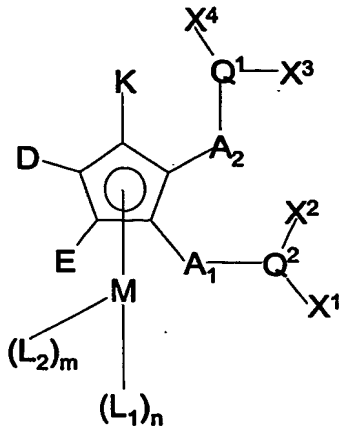
37. A compound as claimed in any one of the preceding claims, wherein n=1, m=0 and L_1 is selected from cyclopentadienyl, phenyl, indenyl or napthyl, preferably unsubstituted cyclopentadienyl.

38. A compound as claimed in any one of the preceding claims, wherein M represents iron or a metal cation thereof.

39. A compound as claimed in any one of the preceding claims obtainable by combining: (a) palladium or a compound thereof; and (b) a compound of formula I as defined in any one of the preceding claims.

40. A process for preparing a compound as defined in any one of claims 1 to 39 comprising combining (a) a Group VIIIB metal or compound thereof; and, (b) a compound of formula I as defined in any one of claims 1 to 38.

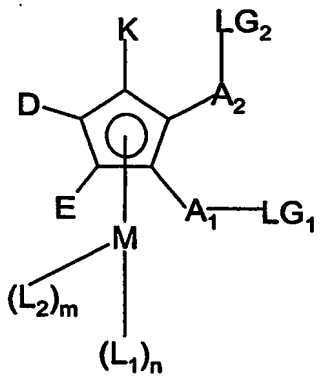
41. A compound of formula I



(I)

wherein A_1, A_2, K, D, E, M, L_2, L_1, Q^1, Q^2, X^1, X^2, X^3, X^4, n and m are as defined in any one of claims 1 to 38.

42. A process for preparing a compound of formula I as defined in claim 41, comprising reacting a compound of formula II wherein A_1, A_2, K, D, E, M, L_1, L_2, n and m are as defined for a compound of formula I, and LG_1 and LG_2 represent suitable leaving groups, with a compound of formula IIIa and IIIb



(II)

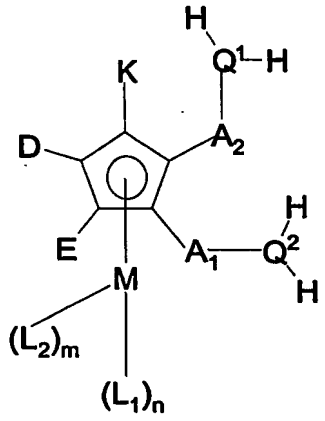
$HQ^2(X^1)X^2$ (IIIa)

$HQ^1(X^3)X^4$ (IIIb)

wherein X^1, X^2, Q^2, X^3, X^4 and Q^1 are as defined in anyone of claims 1 to 38.

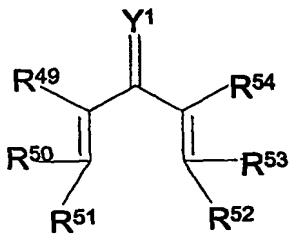
43. A compound of formula II as defined in claim 42.

44. A process for preparing a compound of formula I wherein K, D, E, M, A_2, A_1, L_2, L_1, Q^1, Q^2, m and n are as defined in any one of claims 1 to 38 and X^1 and X^2 together with Q^2 to which they are attached form a ring system of formula Ia as defined in anyone of claims 1 to 38 and X^3 and X^4 together with Q^1 to which they are attached form a ring system of formula Ib as defined in any one of claims 1 to 38, comprising reacting a compound of formula XV

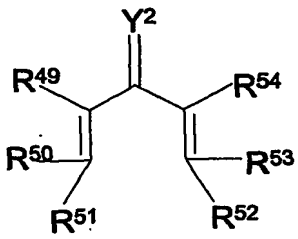


(XV)

wherein K, D, E, M, A_2, A_1, L_2, L_1, Q^1, Q^2, m and n are as defined in any one of claims 1 to 38, with a compound of formula XVIa and XVIb



(XVIa)



(XVIb)

wherein Y^1, Y^2, R^{49} to R^{55} are as defined for a compound of formula I.

45. A compound of formula XV as defined in claim 44.

46. A process for the carbonylation of an ethylenically unsaturated compound comprising contacting an ethylenically unsaturated compound with carbon monoxide and a co-reactant in the presence of a compound as defined in any one of claims 1 to 39.

47. A process as defined in claim 46 wherein the co-reactant includes a hydroxyl group containing compound.

48. A process as claimed in claim 46 or 47 wherein the ethylenically unsaturated compound comprises ethylene, 1,3-butadiene, oct-1-ene or vinyl acetate, preferably ethylene.

49. A process as claimed in any one of claims 46 to 48, further including the step of including a source of anions.

50. A composition comprising a compound as defined in any one of claims 1 to 39 attached to a support.

51. Use of a compound as defined in anyone of claims 1 to 39 or a composition as defined in claim 50 as a catalyst.